TYPE OF REPORT: Quarterly

TIME PERIOD: January-March, 1993

NAME AND LOCATION: Alan Strahler, Boston University

CONTRACT NUMBER: NAS5-31369

OVERVIEW

During the reporting period, we continued our development and supporting research for the MODIS BRDF-Albedo and Land Cover/Land Cover Change products. This work included modeling, validation, and empirical studies involving data analysis.

TASK PROGRESS

BRDF-Albedo Product

Model Development

Modeling activity during this period proceded on several fronts. First, we continued the early development of a new hybrid model that combines principles of radiative transfer and geometric optics to predict the BRDF of surfaces covered with non-homogeneous vegetation. The hybrid model is driven by conditional distributions of path lengths through and around individual plant canopies. It assumes scattering and negative exponential attenuation as calibrated by leaf reflectance, leaf area index, leaf angle distribution, and the index of branch and trunk material. This model is attractive as a candidate for the BRDF/Albedo product because it does not rely on the estimation or field measurement of component signatures. Rather, it is calibrated by physical parameters that may be estimated or measured directly. Inversion of this model thus yields physical parameters rather than scene-dependent signatures.

We also began early development of a stochastic coupled model of surface BRDF and atmosphere. This models the autocorrelation structure in the top-of-atmosphere radiation field induced by having individual plants as discrete scattering media, as well as the modulation of this spatial structure by atmospheric multiple scattering. It is also easily adaptable to the case of discrete vegetation patches. This model will help us understand

how spatial structure is influenced influenced by multiple scattering in the atmosphere at MODIS pixel sizes.

The development of yet another model was completed during this period -- an analytical model of a coupled BRDF and atmosphere system designed specifically for inversion and retrieval of empirical parameters that characterize the shape of the surface BRDF. A manuscript describing this model was completed and submitted for publication in Remote Sensing of Environment.

Validation

In validation, we continued our efforts at validation of the mutual shadowing geometric-optical BRDF model using ground measurements and ASAS data from the FEDMAC experiment conducted by GSFC at Howland, Maine, in 1989 and 1990. This work focuses on forward modeling of the BRDF using measurements of component signatures acquired at the time of ASAS overpasses and comparing them with ASAS observations and with pyranometer measurements of hemispherical albedo collected simultaneously. Initial results showed promising agreement between the model and the measurements.

Land Cover/Land-Cover Change Product

Land Cover

In development of the land cover algorithm, we began an investigation of a very important problem for development and validation of the land cover product -- the effects of aggregation with increasing pixel size of the distribution of land cover types. This work uses data from the Plumas National Forest in California, a region of heterogeneous topography and heterogeneous natural vegetation covers. A thirty meter data base of land covers, provided by other investigators at Boston University, is being resampled at various pixel sizes to understand better how the proportions of land cover units change as a function of their overall abundance and pattern of fragmentation. Early results show that cover proportions can change greatly in the aggregation process.

Land-Cover Change

In development of the land cover change data product, we continued the exploration of the change vector technique as a tool for identifying and

characterizing temporal change in registered data sets of AVHRR images in the Sahel region of West Africa. We are extending the technique from brightness measurements to include measurements of surface temperature, as inferred from a split-window algorithm as applied to AVHRR channels 4 and 5, and to texture measurement of spatial structure that are produced by passing a moving window over each image. Initial indications are that the information from each domain -- spectral, thermal, and spatial -- provides a different and useful input into the identification and characterization of change.

ANTICIPATED ACTIVITIES DURING THE NEXT QUARTER

During the next quarter we will continue our development of models and validations for the BRDF/ALBEDO product. We will focus on continued development of the hybrid and stochastic models. We also expect to pursue some alternative solutions to the coupled analytical surface-atmosphere BRDF model to increase its accuracy. A four-stream solution to the radiative transfer equation for multiple scattering is a possibility we will explore. We also plan to begin development of a Monte Carlo computer model that will simulate the BRDF of a heterogeneous terrain with significant topographic relief. Validation efforts for BRDF and Albedo will continue, centering on the FEDMAC data.

Regarding the development of the land cover/land cover change product, we will continue our studies of the effects of aggregation on land cover proportions and continue our change vector studies with AVHRR data from the Sahel.

PROBLEMS/CORRECTIVE ACTIONS

During this quarter, we did not encounter any significant problems requiring corrective actions beyond the every day problems that occur in research and algorithm development.

OTHER ACTIVITIES

1. The principal investigator attended the MODIS team meeting, March 21-24, 1993.

2. Dr. Rama Nemani, of the University of Montana, a collaborator of team member Steve Running, visited our lab in January for a stay of one week, and worked with Dr. Eric Lambin on land surface temperature derived from the Sahel data study.

PUBLICATIONS

The status of pending publications supported all or in part by this contract and its predecessor is shown below.

Submitted

The following manuscripts were submitted for publication during this reporting period:

Barnsley, M. J., A. H. Strahler, K. P. Morris, and J.-P. Muller, 1993, Sampling the surface bidirectional reflectance distribution function (BRDF): Evaluation of current and future satellite sensors, submitted to Remote Sensing Reviews.

Lambin, E. F. and A. H. Strahler, 1994, Change-vector analysis: A tool to detect and categorize land-cover change processes using high temporal-resolution satellite data, submitted to Remote Sens. Environ.

Liang, S. and A. H. Strahler, 1994, Retrieval of surface BRDF from multiangle remotely sensed data, submitted to Remote Sens. Environ.

Running, S., C. Justice, D. Hall, A. Huete, Y. Kaufmann, J-P. Muller, A. Strahler, V. Vanderbilt, Z-M. Wan, 1994, Terrestrial remote sensing science and algorithms planned for EOS/MODIS, Remote Sens. of Environ., submitted.

Previously Submitted

The following manuscripts were previously submitted and are in the review process:

Moody, A. and A. H. Strahler, 1993, Characteristics of composited AVHRR data and problems in their classification, submitted to International Journal of Remote Sensing.

Revised and Accepted

The following manuscripts were accepted for publication with revision, were revised, and resubmitted during this reporting period:

Abuelgasim, A. A. and A. H. Strahler, 1993, Modeling bidirectional radiance measurements collected by the Advanced Solid-State Array Spectroradiometer (ASAS) over Oregon Transect conifer forests, Remote Sens. of Environ., in press.

Liang, S. and A. H. Strahler, 1993, An analytic BRDF model of canopy radiative transfer and its inversion, IEEE Trans. Geosci. and Remote Sens., in press.

Schaaf, C. B. and A. H. Strahler, 1993, Solar zenith angle effects on forest canopy hemispherical reflectances calculated with a geometric-optical bidirectional reflectance model, IEEE Trans. Geosci. and Remote Sens., in press.

In Press

The following manuscripts were in press during this reporting period:

Liang, S. and A. H. Strahler, Calculation of the angular radiance distribution for a coupled system of atmosphere and canopy media using an improved Gauss-Seidel algorithm, IEEE Trans. Geosci. and Remote Sens., in press.

Published

No new publications appeared during this reporting period.